REMARKS

Claim Status

Claims 1-17 and 20-33 are now pending, with claims 1, 20 and 22 being the only independent claims. Claims 24-33 have been added. The specification has been amended. Claims 1-17 and 20-23 have been amended.

Support for the amendment to independent claims 1, 20 and 22 may be found, for example, at pg. 6, lines 33-37 of the specification as originally filed. Support for new dependent claims 24 and 25 may be found, for example, at pg. 5, line 38 thru pg. 6, line 3 of the instant specification. Support for new dependent claim 26 may be found, for example, at pg. 7, lines 6-13 of the instant specification. Support for new dependent claims 27-29 may be found, for example, at pg. 11, lines 4-5 of the instant specification. Support for new dependent claims 30 and 31 may be found, for example at, pg. 6, lines 33-37 of the specification. Support for new dependent claims 32 and 33 may be found, for example at, pg. 1, lines 10-12 of the specification. No new matter has been added.

Reconsideration of the application, as herein amended, is respectfully requested.

Overview of the Office Action

The specification has been objected to for certain informalities. Withdrawal of this objection is now in order, as explained below.

Claims 1, 4, 6-9 and 11 stand rejected under 35 U.S.C. §102(b) as anticipated by U.S. Patent No. 5,753,130 ("*Cathey*"). Claims 1, 4-6, 9 and 14 stand rejected under 35 U.S.C. §102(b) as anticipated by U.S. Publication No. 2002/0003125 ("*Knappernberger*"). Claims 1, 4,

5, 9 and 13 stand rejected under 35 U.S.C. §102(b) as anticipated by U.S. Publication No. 2001/0014426 ("*Michiels*"). Claims 1, 4, 5, 9 and 12 stand rejected under 35 U.S.C. §102(b) as anticipated by U.S. Patent No. 5,676,853 ("*Alwan*").

Claims 2, 20 and 21 stand rejected under 35 U.S.C. §103(a) as unpatentable over *Cathey* in view of U.S. Patent No. 5,342,453 ("*Olson*"). Claims 3, 22 and 23 stand rejected under 35 U.S.C. §103(a) as unpatentable over *Cathey* in view of U.S. Publication No. 2002/0007792 ("*Seigrist*"). Claim 1 stands rejected under 35 U.S.C. §103(a) as unpatentable over U.S. Patent No. 5,240,558 ("*Kawasaki*") in view of *Knappernberger*. Claim 10 stands rejected under 35 U.S.C. §103(a) as unpatentable over *Kawasaki* in view of *Knappernberger*, and further in view of U.S. Publication No. 2002/0162999 ("*Muller*"). Claim 15 stands rejected under 35 U.S.C. §103(a) as unpatentable over *Knappernberger* in view of *Cathey*. Claim 16 stands rejected under 35 U.S.C. §103(a) as unpatentable over *Cathey* in view of U.S. Publication No. 2002/0176474 ("*Huang*"). Claim 17 stands rejected under 35 U.S.C. §103(a) as unpatentable over *Cathey* in view of *Huang*, and further in view of *Olson* and U.S. Patent No. 5,624,529 ("*Shul*").

Applicants note that the Examiner has stated at the beginning of paragraph 43 (pg. 8) of the Office Action claim 1 is obvious in view of the combination of *Kawasaki* and *Cathey*. However, at page 9 of that paragraph, *Knappernberger* is cited in place of *Cathey*. For purposes of this response, applicants will address the obviousness rejection of claim 1 based on the combination of *Kawasaki* and *Knappernberger*, which applicants assume is the Examiner's intention.

Applicants have carefully considered the Examiner's rejections and the comments provided in support thereof. For the following reasons, Applicants respectfully assert that all claims now presented for examination in the present application are patentable over the cited art.

Descriptive Summary of the Prior Art

Cathey discloses a process that "employs dry etching (also referred to as plasma etching) to fabricate sharp emitter tips" (see col. 2, lines 56-58). In particular, *Cathey* teaches the formation of a mask layer that exposes a silicon substrate which is then etched to form the sharp emitter tips on the substrate (see col. 2, lines 65-67).

Knappernberger discloses a method for forming a high density pattern for field emitter tips for field emission displays using microspheres and/or nanospheres (see paragraph [0003]).

Michiels discloses "structures, lithographic mask forming solutions, mask forming methods, field emission display emitter mask forming methods and methods of forming plural field emission display emitters" (see Abstract).

Alwan discloses "a mask, and a method of making the mask, that comprises a mixture of mask particles and spacer particles distributed across a layer of material on a semiconductor wafer". *Alwan* describes that "[t]he spacer particles space the mask particles apart from one another to prevent the mask particles from clustering together and to control the distance between the mask particles" (see col. 2, lines 43-46).

Olson discloses "an improved high-efficiency solar cell that surpasses the efficiency of the current state-of-the-art GaAs solar cells that are limited in efficiency to less than 24.8% due to the quality of the GaAs emitter layer" (see col. 2, lines 21-25).

Seigrist discloses a cathode electrode for plasma sources of a vacuum coating device, such as for applying coating layers on optical substrates (see paragraph [0002]).

Kawasaki discloses "a process that uniformly roughens or texturizes the surface of semiconductor electrodes used in semiconductor devices" (see col. 2, lines 1-3).

Muller discloses an extremely small field effect transistor structure having improved performance and reduced short channel effects (see paragraph [0009]).

Huang discloses "quantum dot vertical cavity surface emitting lasers (QD-VCSELs) having a low cavity loss and a correspondingly low threshold gain" (see paragraph [0044]).

Shul discloses "a gaseous plasma etching method for III-V compound semiconductor materials having layers comprised of alloys including aluminum, or indium or both" (see col. 1, lines 11-14).

Summary of the Subject Matter Disclosed in the Specification

The following descriptive details are based on the specification. They are provided only for the convenience of the Examiner as part of the discussion presented herein, and are not intended to argue limitations which are unclaimed.

The claimed invention is directed to a method for roughening a light exit surface of an optoelectronic body (see pg. 3, lines 12-13 of the specification as originally filed). In accordance with the claimed invention, an auxiliary mask is used in addition to masking that is performed by small polystyrene balls. This auxiliary mask is comprised of a material that is both different from the material of the body to be etched and different from the material of the polystyrene balls. With the aid of this additional mask, the etching process can be subdivided into two steps. In the first step, the structure of the balls arranged on the surface is transferred into the auxiliary

mask. In the second step, the structure of the auxiliary mask is transferred into the surface of the body to be etched (see pg. 3, lines 20-33 of the instant specification).

In addition to the polystyrene balls, a further material is also provided as a mask. As a result, a much larger selection of material combinations becomes advantageously available, and processes can be optimized with regard to an increased selectivity between the mask material and the material to be etched. For example, some etching methods are unsuitable for a specific material, combination of polystyrene balls and body to be etched. However, these etching methods can nevertheless be used to perform the first etching step in accordance with applicants' etching method. Moreover, it becomes possible to etch the body to be roughened by means of a method which need not necessarily be selective with respect to the polystyrene balls situated on the surface of the body (see pg. 3, line 35 thru pg. 4, line 10 of the instant specification).

Amendments Addressing Section 112 Issues and Formalities

The Examiner has stated that "[t]he chemistry of aluminum gallium indium **phosphate** as claimed is not expressed in the specification, which has only described aluminum gallium indium **phosphite**".

Reference in the application to the material as "aluminum gallium indium phosphite" is the result of a typographical error. Consequently, pg. 2, lines 8 and 33, pg. 5, line 5 and pg. 8, lines 26 and 33 of the specification as originally filed have been amended to change the word "phosphite" to "phosphide". In addition claims 20 and 21 have been amended to delete the word phosphate, and claim 22 has been amended to recite "aluminum gallium indium phosphide".

Based on the originally filed specification, it is clear that the expression "aluminum gallium indium phosphite" is the proper expression to identify a material of the disclosed

semiconductor body, i.e., an LED (see, for example, pg. 2, line 30 thru pg. 3, line 9). The skilled person is knowledgeable that both AlGaInN and AlGaInP are suitable semiconductor materials. At pg. 2, line 34 of the instant specification, for example, the abbreviation AlGanIN is correctly referred to as "aluminum gallium indium nitride". At pg. 2, line 33, AlGaInP should correspondingly be correctly referred to as "aluminum gallium indium phosphide"; the last word of that phrase was inadvertently misspelled with a "t" instead of a "d".

Moreover, at pg. 5, lines 4-9 of the specification the misspelled word "phosphite" is unambiguously associated with AlGaInP. The skilled person readily appreciates that in that composition nitrogen is replaced by phosphorus which belongs to the same group of elements within the periodic table. The nominal oxidation state of the phosphorus is identical to the oxidation state of nitrogen, and the correct spelling should be "phosphide".

In addition, in U.S. Patent No. 3,739,217, cited at pg. 2, lines 7-9 of the instant specification, the material GaP is correctly recited as "gallium phosphide" (see, e.g., col. 1, line 15). Reference to the material GaP in the instant specification at pg. 2, lines 7-8 as "gallium phosphite" is thus an obvious unintended misspelling. Based on all of the foregoing, it is clear that the correct spelling should be "phosphide".

Accordingly, no new matter has been added by way of the foregoing amendments, and withdrawal of the objection to the specification is deemed to be in order.

Patentability of Independent Claim 1 over the Prior art Under 35 U.S.C. §102

Independent claim 1 has been amended to recite "a method for roughening a surface which is a light exit surface of an optoelectronic semiconductor body, comprising the steps of: a) coating the surface of the optoelectronic semiconductor body with a mask layer; ... and d)

etching the optoelectronic semiconductor body at surface locations that are free of the mask layer". Support for the amendment to claim 1 may be found, for example, at pg. 6, lines 33-37 of the instant specification. No new matter has been added.

Independent claim 1 stands rejected based on the teachings of *Cathey*, *Knappernberger*, *Michiels* and *Alwan*. Applicants contend that none of those references anticipate and render now-amended claim 1 unpatentable.

Cathey, *Knappernberger*, *Michiels* and *Alwan* each relate to the formation of an array of sharp emitter tips for a field emission display. *Alwan* (col. 3, line 66 thru col. 4, line 1), for example, describes that "the use of the mask 20 and the formation of the mask 20 is disclosed in association with processing the baseplate 10 of an FED". *Alwan* (col. 4, lines 8-13) further explains that the base layer 12 of such a baseplate 10 may be made from a suitable semiconductive material such as silicon, or the base layer 12 may be made from another material such as glass and covered with a suitable conductive material such as a metal. *Alwan* thus clearly teaches that the disclosed method is directed to applications in which features are formed in a base layer of material which is silicon or glass covered with a metal. There is no teaching in *Alwan* with respect to a light exit surface of an optoelectronic semiconductor body. Indeed, as should be apparent, if the base layer surface is covered, as in *Alwan's* base layer covered with glass, then light could not exit from such a covered surface.

In each of *Cathey*, *Knappernberger*, *Michiels* and *Alwan*, sharp emitter tips are formed in the surface of a silicon substrate, with the tips separated by relatively large areas of an unstructured flat surface of the silicon substrate. For example, *Cathey* (col. 2, lines 65-67; FIG. 1) teaches that "[t]he mask layer is formed such that it exposes the silicon substrate, which silicon substrate is then etched to form the sharp emitter tips".

Amended independent claim 1, on the other hand, recites "a method for roughening a surface which is a light exit surface of an optoelectronic semiconductor body, comprising the steps of: a) coating the surface of the optoelectronic semiconductor body with a mask layer; ... and d) etching the optoelectronic semiconductor body at surface locations that are free of the mask layer". *Cathey*, *Knappernberger*, *Michiels* and *Alwan* each fail to teach or suggest anything remotely similar to these recitations of amended independent claim 1. The silicon substrate disclosed in each of the cited art is not an optoelectronic semiconductor body; there is no light emitted, or that can be emitted, from the silicon substrate disclosed in any of the four documents cited by the Examiner. In *Cathey*, *Knappernberger*, *Michiels* and *Alwan*, the disclosed base materials, i.e., silicon substrates, are quite simply not "light exit surfaces" of "optoelectronic semiconductor bodies."

Based on the teachings of the *Cathey*, *Knappernberger*, *Michiels* and *Alwan*, the production of spaced apart emitter tips on the surface of an optoelectronic semiconductor body is not something that the skilled person would even consider in creating a light exit surface of an optoelectronic semiconductor body to improve light output efficiency of the optoelectronic semiconductor body; the single emitter tips created in silicon substrates as disclosed in the cited art have no effect or, at best, very little effect on the eventual device's light output efficiency. *Cathey*, *Knappernberger*, *Michiels* and *Alwan*, therefore do not anticipate and render unpatentable now-amended independent claim 1.

Reconsideration and withdrawal of the rejection of claim 1 as anticipated by either *Cathey*, *Knappernberger*, *Michiels* and *Alwan* under 35 U.S.C. §102 are accordingly deemed to be in order, and early notice to that effect is solicited.

Moreover, by virtue of the above-discussed differences between the recitations of claim 1 and the teachings of *Cathey*, *Knappernberger*, *Michiels* or *Alwan*, and the lack of any clear motivation for modifying *Cathey*, *Knappernberger*, *Michiels* or *Alwan* to achieve applicants' claimed invention, (and the advantages thereof), independent claim 1 is likewise deemed to be patentable over *Cathey*, *Knappernberger*, *Michiels* and *Alwan* under 35 U.S.C. 103, whether considered individually or in combination.

Patentability of Independent Claim 1 over the Prior art Under 35 U.S.C. §103

The Examiner (at pg. 9 of the Office Action) acknowledges that *Kawasaki* fails to teach or suggest that "the mask bodies were preformed," as recited in independent claim 1, and cites *Knappernberger* for this feature. The combination of *Kawasaki* and *Knappernberger* fails, however, to achieve applicants' claimed method; there is nothing in *Kawasaki* to cure the above-noted deficiency in *Knappernberger*.

Kawasaki fails to teach or suggest anything to bridge the above-discussed deficiency in *Knappernberger*, i.e., "a method for roughening a surface which is a light exit surface of an optoelectronic semiconductor body, comprising the steps of: a) coating the surface of the optoelectronic semiconductor body with a mask layer ... d) etching the optoelectronic semiconductor body at surface locations that are free of the mask layer" as recited in independent claim 1. In particular, *Kawasaki* merely teaches that pillar like structures are formed at an interface between two layers of a silicon-based memory chip to increase the surface of the interface (see, e.g., col. 2, lines 45-56 and Abstract). There is no teaching or suggestion whatsoever in *Kawasaki* with respect to any sort of optoelectronic component or light exit surface, nor any a method for structuring a light exit surface of an optoelectronic component.

Therefore, the combination of *Kawasaki* and *Knappernberger* fails to achieve the method of now-amended independent claim 1 because *Kawasaki* fails to provide that which *Knappernberger* lacks. Independent claim 1 is accordingly deemed to be patentable over the combination of *Kawasaki* and *Knappernberger* under 35 U.S.C. 103.

Patentability of Independent Claims 20 and 22 over the Prior art Under 35 U.S.C. §103

Claims 20 and 22 have also been amended to now recite that the surface is a "light exit surface" of the semiconductor body, i.e., "an optoelectronic semiconductor body having a light exit surface that is patterned with structures" and "an optoelectronic semiconductor body containing aluminum gallium indium nitride or aluminum gallium indium phosphide and having a light exit surface that is patterned with structures", respectively. Support for these amendments may be found, for example, at pg. 6, lines 33-37 of the instant specification. No new matter has been added.

The Examiner (at pg. 7 of the Office Action) acknowledges that *Cathey* fails to teach or suggest "a component containing aluminum gallium indium phosphate," as previously recited in independent claim 20, and cites *Olson* for this feature. The Examiner (at pg. 8 of the Office Action) also acknowledges that *Cathey* fails to teach or suggest "a component containing aluminum gallium indium nitride," as recited in independent claim 22, and cites *Siegrist* for this feature. The combination of *Cathey* and *Olson* or *Siegrist* fails, however, to achieve applicants' claimed component; there is nothing in *Olson* and/or *Siegrist* to cure the above-discussed deficiency in *Cathey*.

Cathey, *Olson* and *Siegrist* each fail to teach or suggest "an optoelectronic semiconductor component with a light exit surface", let alone a "light exit surface" that is patterned with

structures. *Cathey* discloses a field emission display, which is not an optoelectronic component. *Olson* relates to a solar cell, which absorbs light and clearly does not emit light. *Siegrist* relates to a cathode electrode for plasma sources of a vacuum coating device.

Cathey, more particularly, fails to teach or suggest anything with respect to an optoelectronic component, as asserted by the Examiner at pgs. 7 and 8 of the Office Action. In point of fact, the Examiner has misinterpreted the word "optoelectronic"; such an assertion is an improper redefinition of what the skilled person would consider an optoelectronic component, for at least two reasons.

First, an optoelectronic device converts a current into an electromagnetic wave or converts an electromagnetic wave into a current, using hopping of electrons between different quantum mechanical states in a semiconductor material. *Cathey*, on the other hand, teaches a field emission display. In particular, *Cathey* (col. 5, lines 3-7; FIG. 1) teaches a field emission display employing a display segment 22, where each "display segment 22 is capable of displaying a pixel of information, or a portion of a pixel, as, for example, one green dot of a red/green/blue full-color triad pixel". In such a device, however, light in the field emission display is generated by bombarding luminescent material with electrons. A field emission display is therefore not an optoelectronic device, based on this clear operational difference.

Second, an optoelectronic component is a basic electronic element that is typically packaged in discrete form, such as in a housing with two or more connecting leads or metallic pads. These components are intended to be connected together, as by soldering them to a circuit board to create an electronic circuit with an intended function. It is clear to the skilled person what a component configured within the scope of this definition would be, i.e., an optoelectronic device. *Cathey* is utterly silent with respect to an optoelectronic semiconductor body as recited

in now-amended claims 20 and 22. Therefore, claims 20 and 22 are neither anticipated nor rendered obvious by the teachings of *Cathey*, *Olson* and *Siegrist*.

Moreover, there is no teaching or suggestion in the cited art that the disclosed etching methods and mask materials for silicon may also be applied to other materials. In each of the *Cathey*, *Knappernberger*, *Michiels* and *Alwan* documents, there is no teaching or suggestion whatsoever that would provide the skilled person with a reason to consider that other materials apart from silicon or glass are suitable for application of their disclosed methods and mask materials. Therefore, the skilled person would have no reason to combine the methods and materials of either *Cathey*, *Knappernberger*, *Michiels* or *Alwan* for use on the materials "aluminum gallium indium nitride" and/or "aluminum gallium indium phosphide".

Independent claims 20 and 22 are therefore likewise deemed to be patentable over *Cathey*, *Olson*, *Siegrist*, *Knappernberger*, *Michiels* and/or *Alwan* under 35 U.S.C. 103, individually or in combination.

Patentability of Dependent Claims 10 and 16-17 over the Prior art Under 35 U.S.C. §103

The Examiner (at pg. 9 of the Office Action) has acknowledged that *Kawasaki* and *Knappernberger* each fail to teach or suggest "the etching depth (t) in the body as being between 50 and 100 nm", as recited in dependent claim 10, and cites *Muller* for this feature. The Examiner (at pgs. 10-11 of the Office Action) has also acknowledged that *Knappernberger* fails to teach or suggest "an insulation suitable for inductively coupled plasma", as recited in dependent claim 16, and cites *Huang* for this feature. The Examiner (at pg. 11 of the Office Action) has further acknowledged that *Cathey* and *Huang* each fail to teach or suggest "a

mixture of CH_4 and H_2 being used as etching gas", as recited in dependent claim 17, and cites *Shul* for this feature.

Applicants disagree, however, that any combination of *Cathey*, *Kawasaki*, *Knappernberger*, *Muller*, *Huang*, and *Shul* achieves the subject matter of independent claim 1, from which claims 10, 16 and 17 depend. There is nothing in *Muller*, *Huang*, and/or *Shul* to cure the above-discussed deficiencies in *Cathey*, *Kawasaki* and/or *Knappernberger* relating to the lack of teachings of applicants' claimed method for roughening a surface which is a light exit surface of an optoelectronic semiconductor body.

Muller discloses an extremely small field effect transistor structure having improved performance and reduced short channel effects (see paragraph [0009]). *Huang* discloses "quantum dot vertical cavity surface emitting lasers (QD-VCSELs) having a low cavity loss and a correspondingly low threshold gain" (see paragraph [0044]). *Shul* discloses "a gaseous plasma etching method for III-V compound semiconductor materials having layers comprised of alloys including aluminum, or indium or both". Each of these cited references fails to teach or suggest applicants' claimed method for roughening the surface of an optoelectronic semiconductor body, where the surface is a light exit surface, as recited in applicants' independent claim 1. *Cathey*, *Kawasaki*, *Knappernberger*, *Muller*, *Huang*, and *Shul*, individually or in combination, thus fail to teach or suggest the features recited in independent claim 1, and dependent claims 10, 16 and 17 are therefore deemed to be patentable based on their dependency from claim 1.

Dependent Claims

In view of the patentability of independent claims 1, 20 and 22, and for at least the reasons presented above, each of dependent claims 2-17 and 21-23, as well as new dependent

claims 24-33, is believed to be patentable therewith over the prior art. Each of dependent claims 2-17 and 21-33 additionally includes features that serve to still further distinguish the claimed invention over the applied art.

Conclusion

Based on all of the above, applicants submit that the present application is now in full and proper condition for allowance. Prompt and favorable action to this effect, and early passage of the application to issue, are solicited.

Should the Examiner have any comments, questions, suggestions or objections, the Examiner is respectfully requested to telephone the undersigned to facilitate an early resolution of any outstanding issues.

Respectfully submitted,
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